The Cell Membrane and Cellular Transportation

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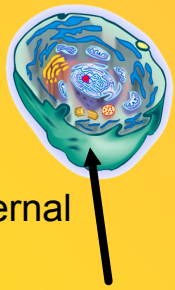
Cell Membrane



Forms a barrier between the cell and the external environment.

Has three main functions:

1) helps the cell retain the molecules it requires. (maintain **Homeostasis**)

2) enables the cell to exclude unwanted molecules.

3) cells recognize one another based on the molecules attached to their membrane

What kind of cells?

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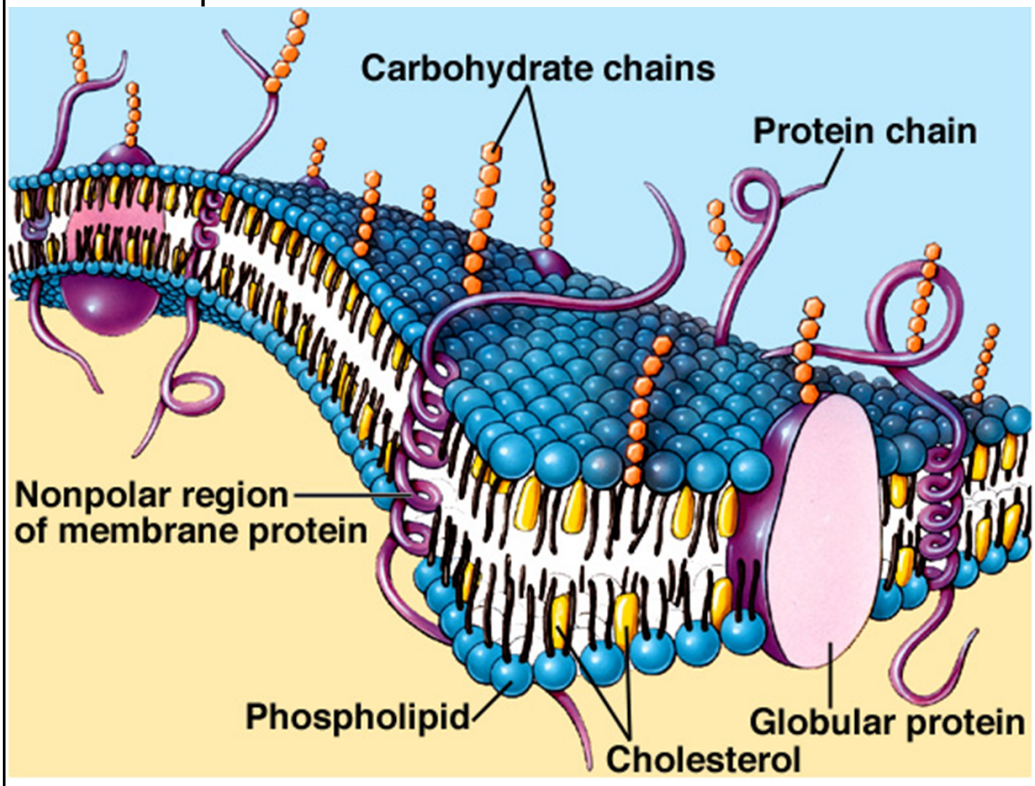
The cell membrane is composed of a double layer of lipids and embedded proteins.



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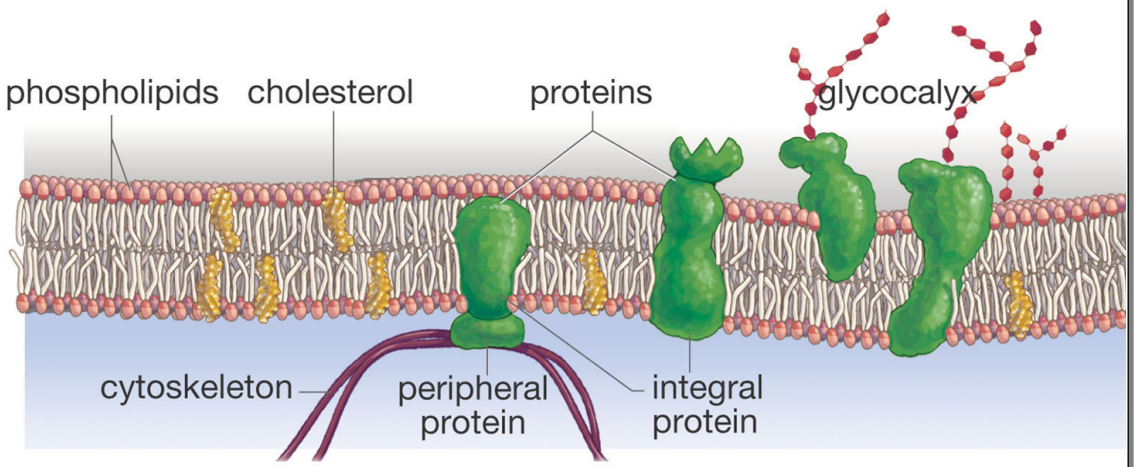
Membrane Components



Phospholipid bilayer Cholesterol Proteins Glycocalyx

Membrane animation

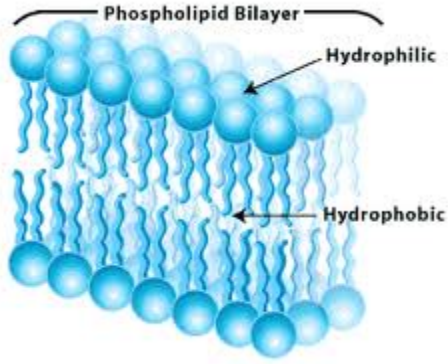
Oct 2-7:49 PM

Phospholipid Bilayer

The lipids (referred to as phospholidpids due to the presence of a phosphate molecule on the lipid) are composed of:

1) one hydrophilic head (hydrophilic = water loving)

2) two hydrophobic tails (hydrophobic = water hating).



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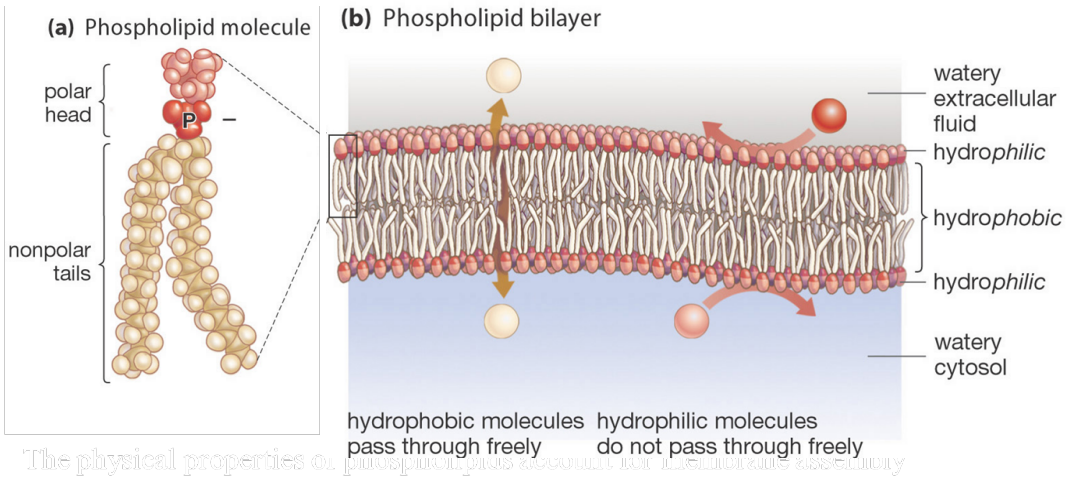

The physical properties of phospholipids account for membrane assembly and many of its properties.

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Cholesterol

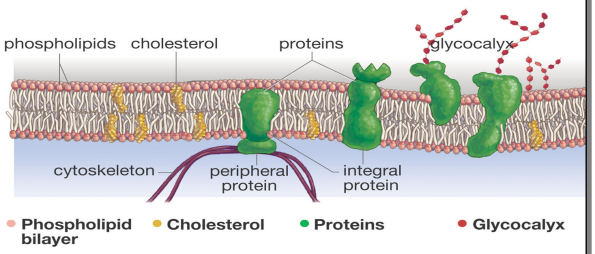
Makes the bilayer stronger, more flexible but less permeable to water-soluble substances.

Glycocalyx

Composed primarily of carbohydrates.

Has several functions:

1) Cell recognition
2) Cell adhesion
3) Protection
4) Permeability barrier



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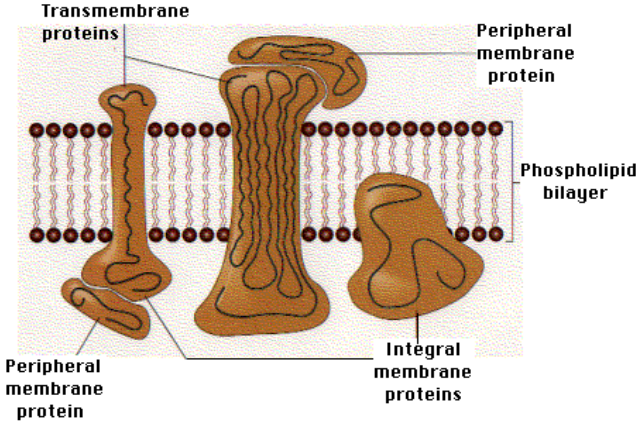
Proteins

There are two major types of proteins in the membrane.

- **Integral Proteins** - completely span the two layers of the cell membrane

- **Peripheral Proteins** - loosely bound to the surface of the membrane



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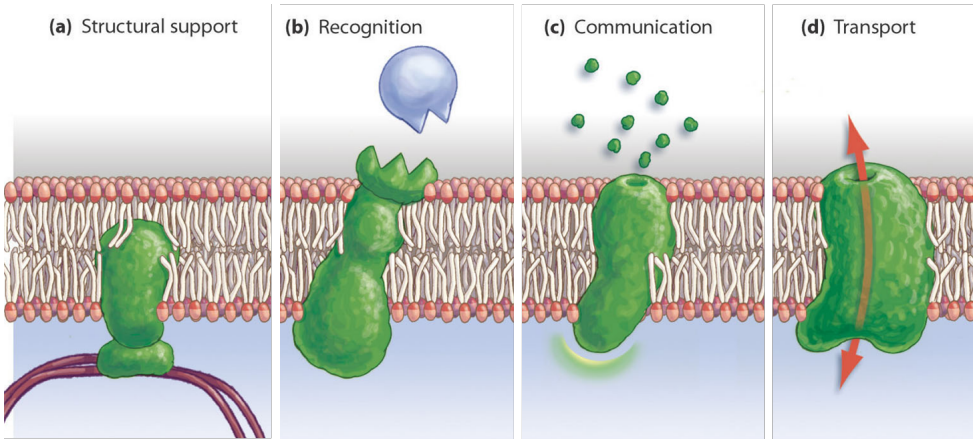
Have four functions:



support - helps maintain the membranes shape.

recognition - identify required molecules and even other cells.

communication - release of chemical messages from the cell.

transport - allow certain proteins to move across the membrane

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Fluid Mosaic Model

- the cell membrane is composed of a mosaic of different components.

- Lipids do not dissolve in, or mix with water. The hydrophilic head and hydrophobic tails of the phospholipids form the barrier known as the cell membrane.
  - heads point to the extracellular and the intercellular

- The loose binding of the components of the cell allow for the movement all components including proteins.

Cell membrane movement animation

Oct 2-8:57 PM

Cellular Transport

- The cell membrane is responsible for maintaining homeostasis - a nearly constant internal environment.

- The cell membrane is selectively permeable
  - allowing some molecules to pass through while preventing others from doing so.

- Multicellular organisms have every cell bathed in a thin layer of extracellular fluid.
  - consists of a mixture of water and dissolved materials.

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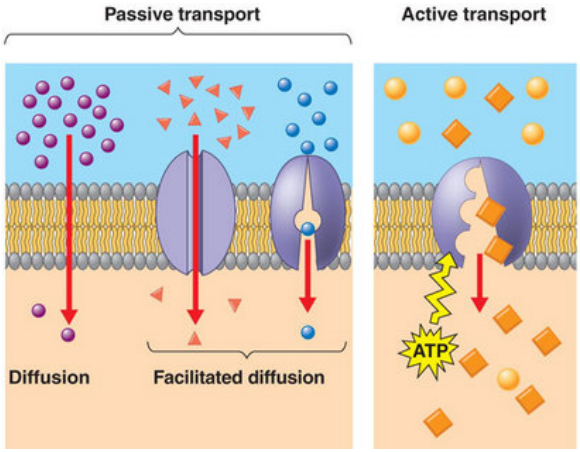
Types of Cellular Transport

1) **Passive Transport** - cell doesn't use energy
Ex. Osmosis and Diffusion



2) **Active Transport** - cell does use energy
Ex. Endocytosis and Exocytosis

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Passive Transport

- movement of material across the cell membrane without the expenditure of energy.

- three basic types of passive transport:

1) Diffusion
2) Osmosis
3) Facilitated Diffusion

Oct 20-8:12 PM

Diffusion

- molecules move about randomly and collide (Brownian Motion) causing molecule concentration in one area to spread outward.

- Diffusion is the movement of molecules from an area of high concentration to an area of low concentration. Particles want to achieve an equilibrium.

- Diffusion is influenced by temperature, concentration, and pressure

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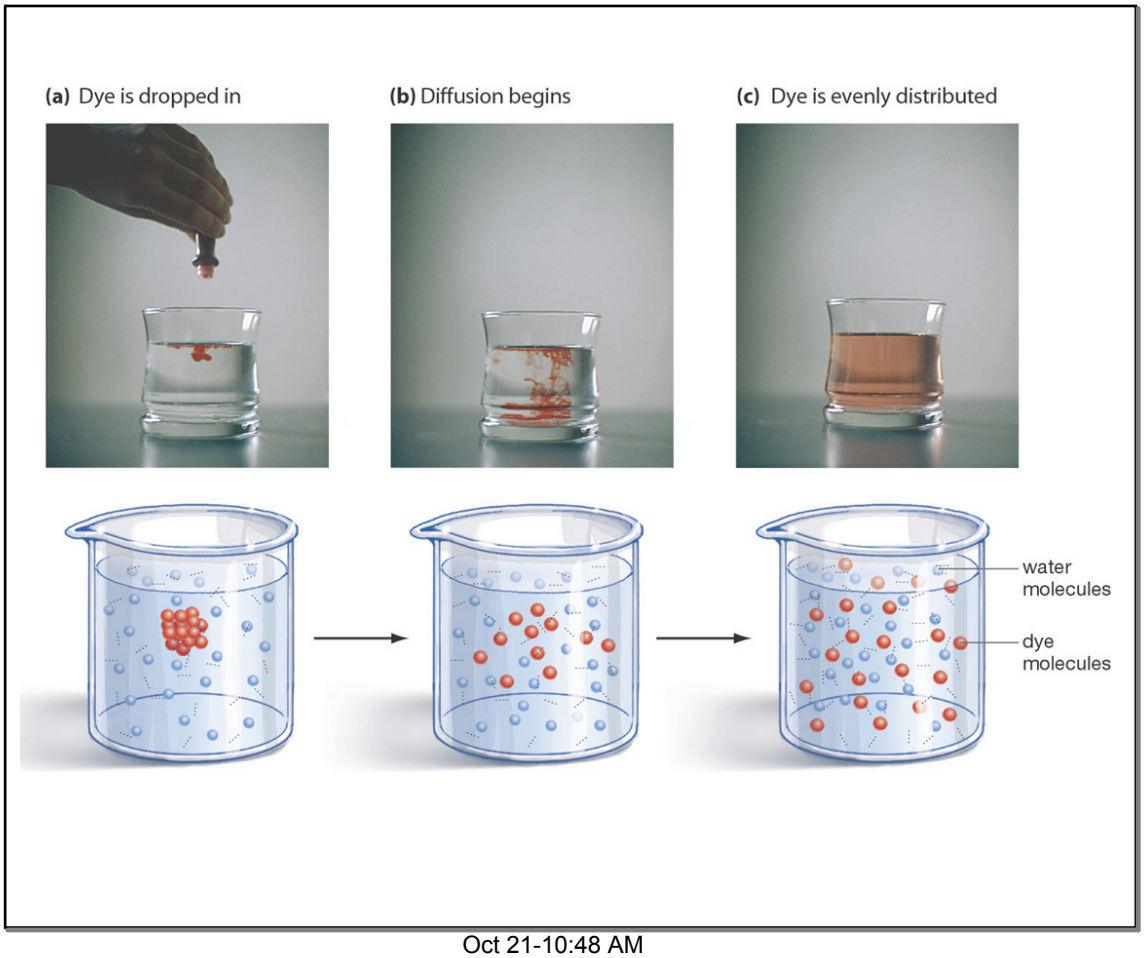

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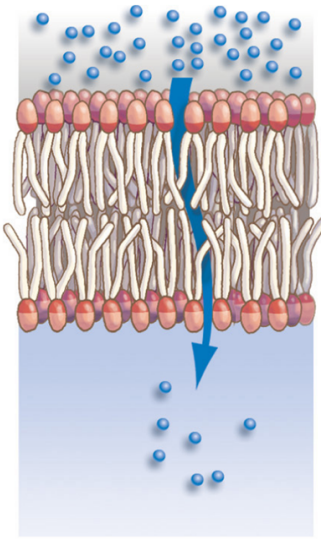
simple diffusion



Materials move down their concentration gradient through the phospholipid bilayer.

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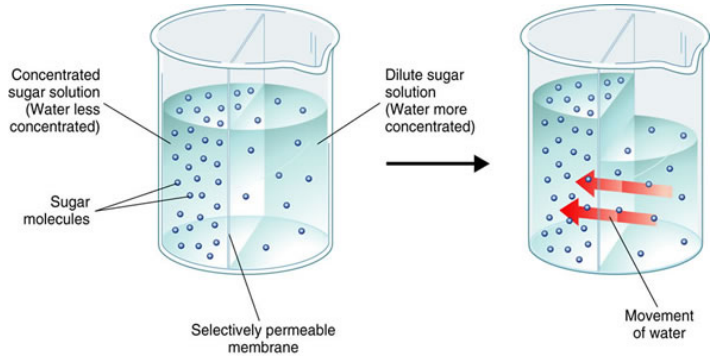
Osmosis

Osmosis - diffusion of water through a selectively permeable membrane from an area of high concentration to an area of low concentration.

- the movement of water into and out of living cells is vital to life processes



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Osmosis Video 1

Osmosis Video 2

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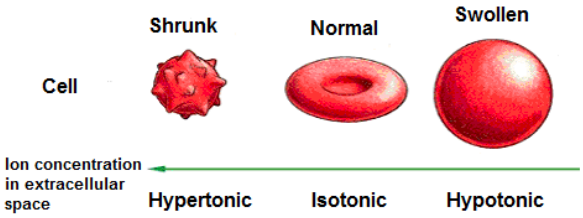
Osmotic Solution Types

Isotonic solution - solutions in which the solute concentration outside the cell is equal to that inside the cell



hypotonic solution - solutions in which the concentration of solutes outside the cell is lower than that found inside the cell

hypertonic solution - solutions in which the concentration of solutes outside the cell is greater than that found inside the cell

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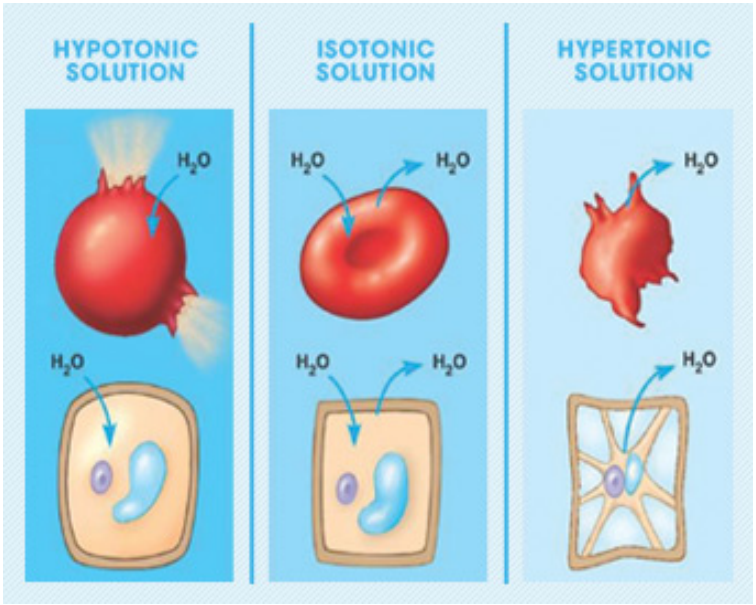

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WHAT ABOUT PLANTS?

turgor pressure - is the pressure exerted by water against the cell membrane and nonliving cell walls of plant cells.

- pushes the cytoplasm of the plant cell against the nonliving cell wall.

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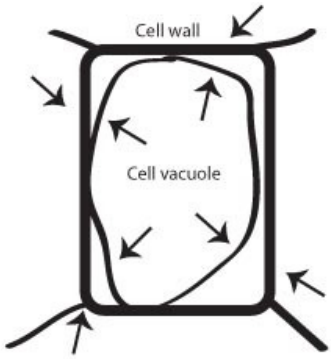
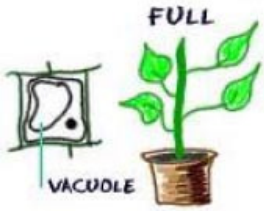
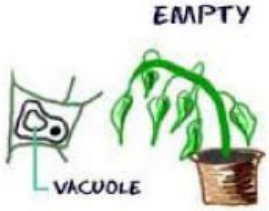


PLANT TEXTURE - a balance between the cell wall and the cell vacuole
The water-storing vacuole pushes outward on the cell wall, keeping it firm and rigid.
At the same time, the cell wall has enough mechanical strength to constrain the vacuole.



A **full vacuole** provides a rigid structure to the plant.



An **empty vacuole** causes the cell walls to shrink and to pull away from neighboring cells. This results in the droopy apearance of wilted plants.

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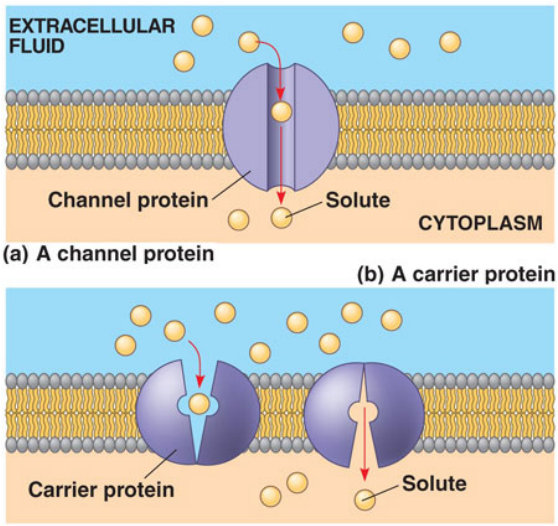
Facilitated Diffusion

- channel proteins and carrier proteins in the cell membrane can aid in passive transport by speeding up the movement of molecules across the membrane.



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- Transport Proteins are specific - they "select" only certain molecules to cross the membrane.

- Transport Proteins are generally used to transport larger or charged molecules.

Facilitated Diffusion Video 1

Passive Transport Review Video

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Active Transport

- the transport of materials against the concentration gradient (from an area of low concentration to an area of high concentration) that requires the expenditure of energy (ATP)

- three types of active transport:
    1) Protein pumps
    2) Endocytosis
    3) Exocytosis

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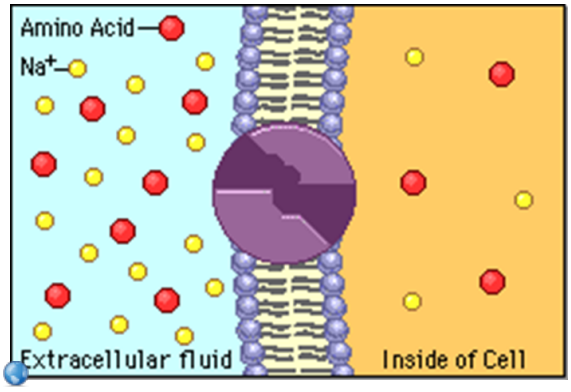
Protein Pumps

- transport proteins that require energy to work.

Example: Sodium/Potassium Pumps are important in nerve responses.



The transport protein changes shape to move molecules: this require energy!

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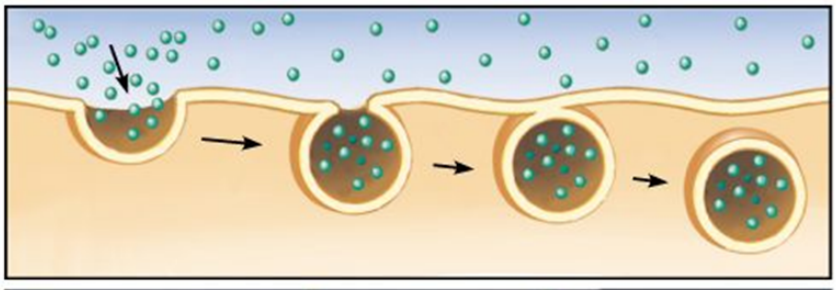
Endocytosis

- is the process by which particles too large to pass through the cell membrane are transported inside the cell.

- cells engulf large particles by extending their cytoplasm around the particle and bring them into the cell. This is how white blood cells destroy bacteria.



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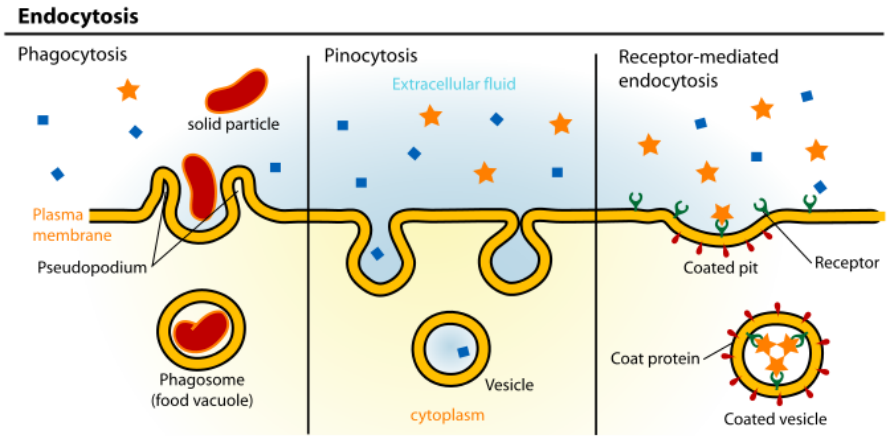
- Two types of endocytosis

1) Pinocytosis - engulfing droplets of liquids by the cell.

2) Phagocytosis - engulfing of solid particles by the cell.



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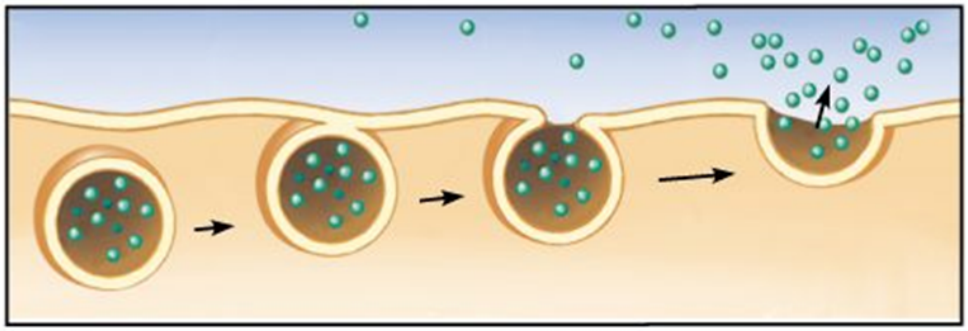
Exocytosis

- the process by which large molecules held within the cell are transported tot he external environment.

- often used in the release of waste materials and hormones.



Endocytosis and Exocytosis Animation

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How Surface Area to Volume Ratio Limits Cell Size

1. A cell is a metabolic compartment where a multitude of chemical reactions occur.
2. The number of reactions increase as the volume of metabolic volume within a cell increases. (The larger the volume the larger the number of reactions)
3.All raw materials necessary for metabolism can enter the cell only through its cell membrane.
4.The greater the surface area the larger the amount of raw materials that can enter at only one time.
5.Each unit of volume requires a specific amount of surface area to supply its metabolism with raw materials. The amount of surface area available to each unit of volume varies with the size of a cell.
6. As a cell grows its SA/V decreases.
7. At some point in its growth its SA/V becomes so small that its surface area is too small to supply its raw materials to its volume. At this point the cell cannot get larger.

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